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SPECIFICATION

# FILTER FOR GAS GENERATOR

## Technical Field

The present invention relates to a filter for a gas generator used in a gas generator for an air bag, the method of manufacture thereof, and a gas generator for an air bag.

## Prior Arts

In pyrotechnic gas generators in which a combustion gas produced by a gas generating agent is used as a medium for inflating an air bag, a coolant/filter is used to cool the combustion gas and to capture the combustion residue. Known coolant/filters thereof include filters formed by the knitting a metal wire and filters formed by laminating wire mesh.

As prior art relating to the present invention, JP-A No. 11-348712 and JP-A No. 2000-342915 can be mentioned.

## Disclosure of the Invention

Because proper actuation of a gas generator for an air bag is required for a period equivalent to the number of years of the life of an automobile (at least 10 years), the coolant/filter, which constitutes a component part thereof, is demanded to be highly durable with respect to vibration (shape retaining property that ensures the same

shape is maintained for the period of the life of an automobile) for a long period.

Accordingly, because the strength and durability of a coolant/filter manufactured by knitting a metal wire is inadequate, its strength is increased by means of a sintering process as described in JP-A No. 11-348712.

However, since the metal wire used for the coolant/filter is an iron wire or stainless steel wire, the sintering temperature, for example, in the sintering of iron (whose melting point is 1535°C) is very high. For this reason, a quantity of consumed energy is increased and a time required to perform the sintering is long whereby, to that extent, the manufacturing cost is increased.

A purpose of the present invention provides a filter for a gas generator of a quality equal to or better than the conventional products, and a method of manufacturing a filter for a gas generator that facilitates the production of a high quality coolant/filter under more relaxed conditions.

In addition, another purpose of the present invention provides a gas generator for an air bag employing the filter for a gas generator.

The invention of claim 1 provides, as a means for solving the problem, a filter for a gas generator, comprising a tubular material formed by knitting a coated

metal wire in which a metal wire corresponding to a core wire is coated with a lower melting point metal, wherein the lower melting point metal is a metal having a melting point lower than the metal of the core wire, and the intersecting parts of the coated metal wires are bonded by the affixing and solidifying of the molten lower melting point metal.

A melting point of the lower melting point metal for coating the metal wire of the core wire is preferably 20°C or more lower than a melting point of the metal of the core wire, and more preferably 30°C or more lower.

The metal wire of the core wire is preferably selected between iron wire and stainless steel wire, and the lower melting point metal for coating the core wire is preferably selected among copper, zinc, aluminium, tin or lead.

The invention of claim 4 provides, as another means for solving the problem, a method of manufacturing the above filter for a gas generator, comprising a molding step for producing a tubular material in which the metal wire corresponding to the core wire is coated with a lower melting point metal, and the coated metal wire, in which the lower melting point metal is a metal having a melting point lower than the metal of the core wire, is knitted, and also comprising a heat processing step in which the above tubular material is kept at a temperature not less

than a melting point of the lower melting point metal for coating the core wire but less than the sintering temperature of the metal of the core wire, and is then cooled.

The tubular material in the molding step preferably has an inner diameter of 3 to 80mm, an outer diameter of 10 to 90mm, a height of 5 to 300mm, and a mass of 10 to 400g.

In the heat processing step, the heat processing is preferably performed at a temperature that is 10°C or more higher than a melting point of the lower melting point metal that coats the core wire (and more preferably a temperature of 30°C or more), but at a temperature of 10°C or more lower than a melting point of the metal of the core wire (and more preferably a temperature of 50°C or more lower).

The "filter" of the present invention refers to a component part that has a function for cooling a combustion gas and/or a function for arresting combustion residues.

Any metal wire is used as the "coated metal wire" of the present invention, as long as the core wire surface thereof is covered by a lower melting point metal, for example, a coated wire metal in which the core wire has been metal plated.

It should be noted that the melting points referred to in the present invention are based on the description in Chemical Dictionary, Volume 1, 1st Edition, Published on 20 October 1989, Tokyo Kagaku Dojin Co., Ltd.

The invention of claim 7 provides, as another means for solving the problem, the present invention provides a gas generator for an air bag comprising a housing having a gas discharge port, an ignition means actuated by the impact, a combustion chamber storing a gas generating agent which is ignited and burned by the ignition means to generates a combustion gas, and a filter for filtering and cooling a combustion gas, wherein the above filter for a gas generator is used as a filter.

In the filter for a gas generator obtained by the manufacturing method according to the present invention, since the intersecting parts of the knitted coated metal wire are affixed as a result of the solidification of a molten lower melting point metal, and therefore, the filter has a good overall shape retaining property.

In addition, the filter for a gas generator of the present invention has a good shape retaining property for a long period, the reliability of the gas generator for an air bag in which the above filter is employed is improved.

Brief Description of the Diagrams

Fig. 1 is a conceptual diagram for explaining the tubular material in the manufacturing step or the exterior form of the gas generator as a final product.

Fig. 2 is a conceptual diagram of another aspect of the filter for a gas generator shown in Fig. 1.

Fig. 3(a) is a conceptual diagram for explaining the state of the metal wire after the molding step, and Fig. 3(b) is a conceptual diagram for explaining the state of the metal wire after the heat processing step.

Embodiment of the Invention

A method of manufacture for producing the filter for a gas generator of the present invention will be described, and in the following embodiment, a copper-plated iron wire is employed. Fig. 1 is a conceptual diagram for explaining the tubular material in the manufacturing step or the exterior form of a filter for a gas generator as a final product.

First, in the molding step, a copper-plated iron wire 1 is knitted to produce the túbular material as shown in Fig. 1. One or two or more of copper-plated iron wire can be used. It should be noted that the copper that constitutes the plating metal refers to copper and an alloy of which the principle component is copper.

The dimensions used for any well-known filter for a gas generator can be adopted as the dimensions of the

copper-plated iron wire. For example, the cross-sectional area can be selected within the range of 0.03 to 0.8mm$^2$.

From the viewpoint of increasing the fixing strength of intersecting parts of the iron wire and increasing a shape retaining property of the filter as a whole, a thickness of the copper-plated layer is preferably 0.5 to 10 μm, and more preferably 1 to 3 μm. In addition, if a thickness of the copper-plated layer (that is, a quantity of coated copper) is within the abovementioned range, this is a sufficient quantity for the action of moving and affixing the molten copper to the intersecting parts of the iron wire, but no resultant dripping of the molten copper to block the filter gaps occurs.

The plated metal wire of the filter for a gas generator for an automobile air bag disclosed in JP-A No. 2000-342915 can be used as the copper-plated iron wire of the present invention.

Although there are no particular restrictions to the method for the knitting of the tubular material, a method in which a cylindrical core material is used to knit a copper-plated iron wire or the like on the perimeter thereof may be adopted. The outer diameter of this cylindrical core material is equivalent to the inner diameter of the tubular material produced in the molding step.

Although there are no particular restrictions to the method of knitting, hosiery knitting, winding, plain weaving, twilled weaving, plain Dutch weaving and twilled Dutch weaving are preferred.

An example of a method of cylindrically knitting a copper-plated iron wire such as the above is the method described in the paragraphs 【0013】 to 【0016】 of JP-A No. 2001-171472.

Although the dimensions of the tubular material produced in the molding step are determined in accordance with a type of a target gas generator, they can be selected within the range of 3 to 80mm of an inner diameter, 10 to 90mm of an outer diameter, 5 to 300mm of a height and 10 to 400g of a mass.

The tubular material produced in this way has an innumerable number of intersecting parts formed as a result of the intersecting netted iron wires produced by knitting one or two or more copper-plated iron wires into multi-layers.

It should be noted that the mesh member (wire screen) 4 shown in Fig. 2 that functions as a filter material may be assembled with the filter, as shown in Fig. 1.

Next, in a heat processing step, the tubular material produced in the molding step is kept at a temperature not less than a melting point of copper but less than the temperature of sintering of the iron, and is then cooled.

This heat processing can be performed when a core material is employed in the molding step, or the heat processing may also be performed after the core material is removed.

The lower limit temperature of the heat processing is preferably a temperature that is 10°C or more higher than a melting point of the copper (1083°C), and more preferably a temperature that is 30°C or more higher.

The upper limit of the heat processing is preferably a temperature that is 10°C or more lower than a melting point of the iron (1535°C) that forms the core wire, and more preferably 50°C or more lower. Because the heat processing is performed at a temperature lower than the temperature of sintering of the iron that forms the core wire in this way, compared to a method of heat processing performed at the temperature of sintering of iron, the quantity of energy consumed is reduced.

When the tubular material of the above dimensions and shape is heat-processed in the above range of temperature, the heat processing time is preferably 10 to 120 minutes.

After heat processing, the system is cooled to room temperature. Thereafter, if required, a molding means such as compression molding may be applied.

As is described above, the tubular material produced in the molding step includes, as shown in Fig. 3(a) (partial conceptual diagram of the tubular material), an

innumerable number of intersecting parts 2 formed by intersecting the copper-plated iron wires 1.

By heat-processing this tubular material at the prescribed temperature conditions in the heat processing step, no change in the iron wire that is the core wire occurs, and all or part only, of the plated copper can be melted. As a result, as shown in Fig. 3(b), the molten copper 3 infiltrates gaps of the above intersecting parts 2 and adheres to the surface of the intersecting parts. At this time, the molten copper 3 bonds the intersecting parts adjacent in the radial direction of the tubular material to each other.

Thereafter, as a result of cooling, the molten copper 3 solidifies whereupon, because each of the innumerable intersecting parts and the adjacent intersecting parts are firmly fixed by the copper, the shape retaining property of the filter as a whole is improved.

From the viewpoint of the normal actuation of the gas generator, the filter gas generator of the present invention is preferably one in which the overall pressure loss for an air flow quantity of $1m^3$/min is 0.02 to 500kPa. The method of measurement of pressure loss employed in the present invention is based on the method disclosed in the paragraph no. 67 and Fig. 8 of JP-B No. 2926040.

The filter for a gas generator of the present invention can be employed in any gas generator for an air

bag as long as the generator comprises a housing having a gas discharge port, an ignition means, a combustion chamber storing a gas generating agent and a filter for filtering and cooling a combustion gas. For example, the filter of the present invention can be employed in the gas generators disclosed in Fig. 1 of JP-A 10-1811516, Fig. 1 of JP-A 2001-97175 and Fig.1 of WO-A 00/48868.

Examples

Example 1

Molding step

The tubular material shown in Fig. 1 having the inner diameter of 61mm, the outer diameter of 72mm, the height of 57mm and the mass of 170g was obtained by knitting (hosiery knitting) a copper-plated iron wire (having the cross-sectional area of $0.2\text{mm}^2$ and the copper layer thickness of approximately 2μm) on the perimeter of a cylindrical core material having the diameter of 60mm.

Heat processing step

The tubular material obtained in the molding step was placed in a heating furnace and, after being kept therein for 10 minutes at 1180°C, the material was left as it is in a state of suspended heating and allowed to cool to room temperature, thereby producing a filter.

In the observation of the external appearance of the produced filter, it was confirmed that copper had affixed to the intersecting parts of the iron wires. The pressure

loss of the filter was 0.25kPa. Operational tests were conducted on a gas generator accommodating this filter (gas generator in Fig. 1 of JP-A 10-181516. 40g of the gas generating agent comprising ammonium bi-tetrazole salt/basic copper nitrate/cellulose acetate (22.7 mass%/ 74.3 mass%/3 mass%) was used) and then, the device after activation was disassembled whereupon it was confirmed by an eye check that no slack or displacement of the filter had occurred.